# Extreme weather in nested ensembles: the weatherathome experiment

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# **Core science question: understanding the factors behind the 2010 Russian heatwave**

#### First, clarify the question:

- "They used to say we're changing the odds, we're loading the dice that make it more likely that we'll get extreme weather events. Now the change is we're not only loading the dice, we're painting more dots on the dice. We're not only rolling more 12s, we're rolling 13s and 14s and soon 15s and 16s." (Al Gore, September 2011)
- Q1: "Could this event have occurred in the absence of human influence on climate?"
- Q2: "How much has human influence on climate increased the odds of this event occurring?"







# The 2010 Russian heatwave in geopotential and surface temperature (from Dole et al, GRL, 2011)









#### **Competing interpretations of attribution**

#### From the abstract of Dole et al, 2011:

 "...such an intense event could be produced through natural variability alone. ... similar atmospheric patterns have occurred with prior heat waves in this region. We conclude that the intense 2010 Russian heat wave was mainly due to natural internal atmospheric variability."

#### These statements are not incompatible with:

 The global temperature trend over the past 50 years, most of which is attributable to human influence, substantially increased the risk of a heat-wave of this magnitude.



# GJ van Oldenborgh: Western Russia JJA temperatures regressed onto global mean ΔT

#### Regression model:

monthly regional  $\Delta T = \beta x$  global mean  $\Delta T$  + noise

- Significant in all months except July, with stronger regional temperature changes in winter.
- Stronger relationship over 1950-2009 period.









Change in return-time of 2010 temperatures associated with 1950-2009 global trends

180

 Return-time of 2010 event versus mean climate 1949-2009

55E

 Return-time after subtracting component varying with global ΔT

180



# What does modelling tell us? Results from weatherathome.net

- Dole et al noted one of a 50-member ensemble was 2010-like.
- Need larger ensembles, since the event was unpredictable.
- Run prescribed-SST simulations 1950-2010.
- Repeat with estimated pattern of human influence removed

- Large ensembles, short runs, perfect for distributed computing.
- See Cameron Rye's poster.



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Pattern of geopotential height associated with July Western Russian temperatures

ERA-interim
HadAM3P-N96
1979-2010
ensemble



## Temperature anomalies versus amplitude of geopotential height pattern – uncorrected









## Temperature anomalies versus amplitude of geopotential height pattern – bias corrected









### Preliminary results: change in return-time of heat-wave-like events, 1960s-2000s









### Preliminary results: change in return-time of heat-wave-like events, 1960s-2010









#### Conclusions

- Empirical analysis, supported by large-ensemble simulation using weather*at*home.net, suggests largescale temperature changes since 1950 have increased the risk of a 2010-like Russian heat-wave.
- Most of the warming over the past 50 years is very likely attributable to human influence.
- Specific conditions in 2010 are less important than the multi-decadal trend.
- Still need to assess:
  - Sensitivity to model physics & pattern of SST change.
  - Possible countervailing regional anthropogenic influences.





#### So, are we disagreeing with Dole et al?

- Not yet (these are only preliminary results).
- Even if these results prove robust, this is not a fundamental disagreement. Dole et al note we are "on the cusp" of a rapid increase in risk. Large ensembles allow early detection.
- Size of 2010 anomaly was substantially larger than estimated increase in 100-year-return-time events: So an event can be both
  - "mostly natural" in terms of magnitude and
  - "mostly anthropogenic" in terms of fraction attributable risk







### Should we measure human contribution in terms of size of an event of a given return time?









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# Or in terms of increased risk of an event of a given magnitude?



# Evidence that thresholds matter: impact of droughts and heatwaves on Chinese wheat-yield

EQUIP project: end-to-end quantification of impact projections. Highlights importance of thresholds.



#### The importance of clarifying the question

- A small anthropogenic contribution to the magnitude of an event can be consistent with a large contribution to the risk of exceeding a threshold.
- Contribution to risk is most relevant if events are self-reinforcing & impacts are non-linear.
- Important to avoid the question "could this event have occurred naturally?" – especially if it diverts attention to the early- or pre-instrumental record.
- Could whoever is advising Gore to ask whether we are painting more dots on the dice please stop?





